PRELIMINARY DATA SHEET

SKY85803: Dual-Band 802.11a/b/g/n/ac WLAN Front-End Module

Applications

- 802.11b DSSS WLAN
- 802.11a/g OFDM WLAN
- 802.11n/ac WLAN
- Access points, PCMCIA, PC cards

Features

- All RF ports matched to 50 Ω
- Integrated 2.4 GHz PA, 5 GHz PA, transmit filter, transmit/receive switches, and diplexers
- Integrated power detector for each transmit chain
- Power:
  - +21 dBm, 802.11b, 11 Mbps, ACPR = +35 dBc
  - +18 dBm @ 3.0% EVM, 802.11n, 64 QAM, 2G
  - +16 dBm @ 3.0% EVM, 802.11n, 64 QAM, 5G
  - +16 dBm @ 1.8% EVM, 802.11ac, 256 QAM, 2G
  - +13 dBm @ 1.8% EVM, 802.11ac, 256 QAM, 5G
  - Single supply voltage: 3.3 V ± 10%
- Small LGA (24-pin, 4 x 4 mm) package (MSL3, 250 °C per JEDEC J-STD-020)

Skyworks Pb-free products are compliant with all applicable legislation. For additional information, refer to *Skyworks Definition of Lead (Pb)-Free*, document number SQ04-0073.

Description

The SKY85803 is a complete 802.11a/b/g/n/ac WLAN RF Front-End Module (FEM) that provides all the functionality of the Power Amplifiers (PAs), filtering, power detector, transmit/receive (T/R) switch, diplexers, and associated matching.

The device provides a complete 2.4 GHz and 5.0 GHz WLAN RF solution from the output of the transceiver to the antenna in an ultra-compact form factor. The SKY85803 delivers < 2% EVM at rated AC power, which meets the stringent linearity conditions of the 802.11ac standard.

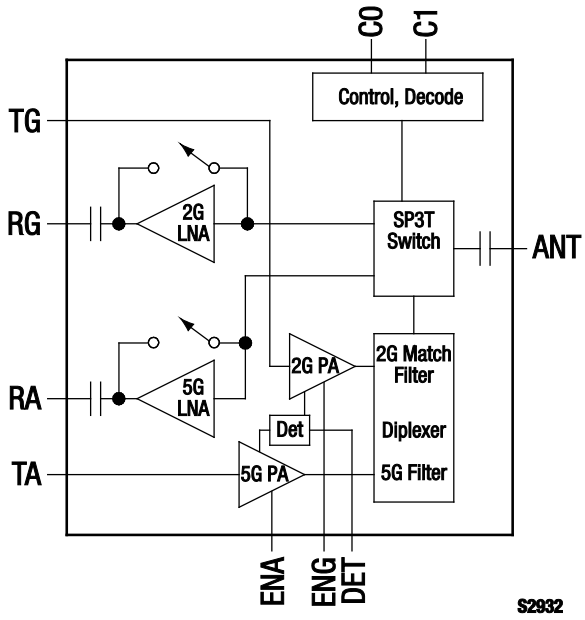


Figure 1. SKY85803 Block Diagram

Designed for ease of use, all RF ports are matched to 50 Ω to simplify PCB layout and the interface to the transceiver. The device also includes a transmitter power detector with 20 dB of dynamic range for each transmit chain. Each PA has a separate digital enable control for transmitter on/off control. The power ramp rise/fall time is < 0.4 µs.

The SKY85803 also provides a notch filter from 3.260 to 3.267 GHz and 3.28 to 3.89 GHz before the input of each 2.4 GHz and 5.0 GHz PA, respectively.

The SKY85803 is manufactured in a compact, 4 x 4 mm, 24-pin Land Grid Array (LGA) package.

A functional block diagram is shown in Figure 1. The pin configuration and package are shown in Figure 2. Signal pin assignments and functional pin descriptions are provided in Table 1.

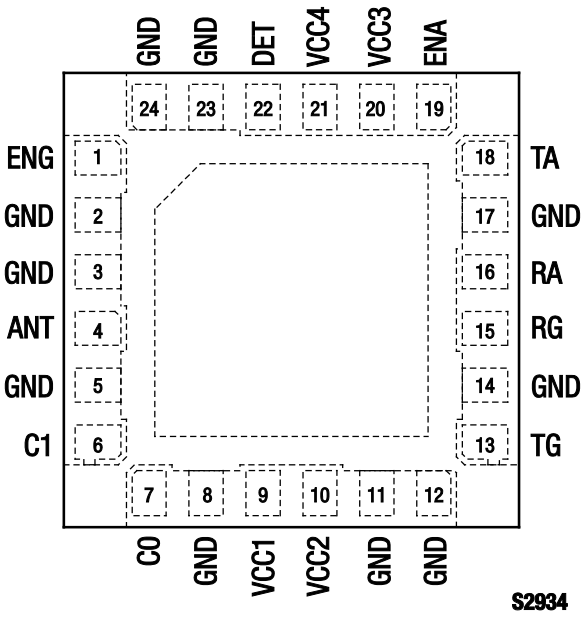


Figure 2. SKY85803 Pinout – 24-Pin LGA
(Top View)

Table 1. SKY85803 Signal Descriptions

Pin #	Name	Description	Pin #	Name	Description
1	ENG	2.4 GHz PA enable	13	TG	2.0 GHz transmit RF input
2	GND	Ground	14	GND	Ground
3	GND	Ground	15	RG	2.0 GHz receive RF output
4	ANT	Antenna	16	RA	5.0 GHz receive RF output
5	GND	Ground	17	GND	Ground
6	C1	Switch control logic 1	18	TA	5.0 GHz transmit RF input
7	C0	Switch control logic 0	19	ENA	5.0 GHz PA enable
8	GND	Ground	20	VCC3	Supply voltage
9	VCC1	Supply voltage	21	VCC4	Supply voltage
10	VCC2	Supply voltage	22	DET	2.0/5.0 GHz power detector output
11	GND	Ground	23	GND	Ground
12	GND	Ground	24	GND	Ground

Table 2. SKY85803 Absolute Maximum Ratings

Parameter	Symbol	Minimum	Maximum	Units
Supply voltage	V_{CC}	–0.3	+3.6	V
PA enable voltage (pins ENA and ENG)		–0.3	+3.6	V
Maximum input power to TA and TG pins with ANT terminated in 6:1 load or better	P_{IN}		+12	dBm
Operating temperature	T_A	–40	+85	°C
Storage temperature	T_{STG}	–40	+150	°C
Switch logic control	C0, C1	0	3.6	V
LNA power (receive mode)	P_{RX}		–3	dBm

Note: Exposure to maximum rating conditions for extended periods may reduce device reliability. There is no damage to device with only one parameter set at the limit and all other parameters set at or below their nominal value. Exceeding any of the limits listed here may result in permanent damage to the device.

***CAUTION**: Although this device is designed to be as robust as possible, Electrostatic Discharge (ESD) can damage this device. This device must be protected at all times from ESD. Static charges may easily produce potentials of several kilovolts on the human body or equipment, which can discharge without detection. Industry-standard ESD precautions should be used at all times. The SKY85803 ESD threshold level is 1 kV (ANT pin zap to ground) and 250 V (all other pins).*

Table 3. SKY85803 Recommended Operating Conditions

Parameter	Symbol	Minimum	Typical	Maximum	Units
Supply voltage	V_{CC}	3.0	3.3	3.6	V
Operating temperature	T_A	–40	+25	+85	°C

Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY85803 are provided in Table 2. The recommended operating conditions are specified in Table 3 and electrical specifications are provided in Tables 4 through 12.

Typical performance characteristics of the SKY85803 are illustrated in Figures 3 and 4.

Table 4. SKY85803 Electrical Specifications: DC Characteristics (Note 1)
(V_{CC} = 3.3 V, T_A = +25 °C, All Unused Ports Terminated with 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
Total 802.11a transmit supply current	I_{CQ_A}	No RF		165		mA
	I_{CC_A}	P_{OUT} = +16 dBm, 54 Mbps, OFDM signal, 64 QAM		220	250	mA
Total 802.11g transmit supply current	I_{CQ_G}	No RF		135		mA
	I_{CC_G}	P_{OUT} = +18 dBm, 54 Mbps, OFDM signal, 64 QAM		185	200	mA
Total 802.11b transmit supply current	I_{CC_B}	P_{OUT} = +21 dBm, 11 Mbps, CCK signal, BT = 0.45		205	220	mA
Total 802.11ac transmit supply current, 2G	I_{CC_AC2G}	P_{OUT} = +16 dBm, 256 QAM, MCS9, 40 MHz		155	165	mA
Total 802.11ac transmit supply current, 5G	I_{CC_AC5G}	P_{OUT} = +13 dBm, 256 QAM, MCS9, 80 MHz		190	210	mA
Total receive supply current, 2G	I_{CC_RX2}	ENG = ENA = 0 V, LNA on, switch condition 1			12	mA
Total receive supply current, 5G	I_{CC_RX5}	ENG = ENA = 0 V, LNA on, switch condition 4			12	mA
Total supply current	I_{CC_OFF}	No RF, ENG = ENA = 0 V, switch condition 3 or 6		65	200	µA

Note 1: Performance is guaranteed only under the conditions listed in this Table.

Table 5. SKY85803 Electrical Specifications: Logic Characteristics (Note 1)
(V_{CC} = 3.3 V, T_A = +25 °C, All Unused Ports Terminated with 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
Logic high voltage for ENG and ENA (module on)	V_{ENH}		1.8		V_{CC}	V
Logic low voltage for ENG and ENA (module off)	V_{ENL}		0		0.5	V
Input current logic high voltage (ENG and ENA)	I_{ENH}			350	400	µA
Input current logic low voltage (ENG and ENA)	I_{ENL}			0.2		µA

Note 1: Performance is guaranteed only under the conditions listed in this Table.

Table 6. SKY85803 Electrical Specifications: Switch Characteristics (Note 1)
(V_{CC} = V_{EN} = 3.3 V, T_A = +25 °C, All Unused Ports Terminated with 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
Control voltage (on state)	V_{CTL_ON}		3.0		3.6	V
Control voltage (off state)	V_{CTL_OFF}		0		0.2	V
Low loss switch control voltage	SW_{ON}	High state = V_{CTL_ON} – V_{CTL_OFF}	2.8		V_{CC}	V
High loss switch control voltage	SW_{OFF}	Low state = V_{CTL_OFF} – V_{CTL_OFF}	0		0.3	V
Switch control bias current RF applied No RF	I_{CTL_ON}	C0 and C1 pins driven high			 100 30	 µA µA
Control input capacitance	C_{CTL}				100	pF

Note 1: Performance is guaranteed only under the conditions listed in this Table.

Table 7. SKY85803 Electrical Specifications: 2.4 GHz Transmit Characteristics (1 of 2) (Note 1)
(V_{CC} = ENG = C0 = 3.3 V, ENA = C1 = 0 V, T_A = +25 °C, All Unused Ports Terminated with 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
Frequency range	f		2400		2500	MHz
Output power, 802.11g	$P_{OUT\_802.11G}$	54 Mbps OFDM signal, 64 QAM, DEVM = 3%, input signal EVM < 1%, 802.11g mask compliant		+18		dBm
Output power, 802.11n	$P_{OUT\_802.11N}$	OFDM signal, MCS7, HT40, DEVM = 3%, 802.11n mask compliant, ±11 MHz offset, RBW = 100 kHz, VBW = 30 kHz DEVM = 2%		 +18 +17		 dBm dBm
Output power, 802.11ac	$P_{OUT\_802.11AC}$	40 MHz, 256 QAM, MCS9, DEVM = 1.8%, 802.11ac mask compliant DEVM = 1.2%		 +16 +15		 dBm dBm
Output power, 802.11b	$P_{OUT\_802.11B}$	11 Mbps CCK signal, BT = 0.45, ACPR (±11 MHz offset) < –35, ACPR (±22 MHz offset) < –56		+21	+22	dBm
1 dB compression point	P1dB		+24.0	+24.5		dBm
Small signal gain	$\|S21\|$		25		30	dB
Small signal gain variation over band	$\Delta\|S21\|$			1	2	dB
Small signal gain @ ½ VCO frequency	$\|S21\|\_1.6$	1640 to 1942 MHz		12	20	dB
Small signal gain @ VCO frequency	$\|S21\|\_3.2$	3216 to 3312 MHz			0	dB

Table 7. SKY85803 Electrical Specifications: 2.4 GHz Transmit Characteristics (2 of 2) (Note 1)
(V_{CC} = ENG = C0 = 3.3 V, ENA = C1 = 0 V, T_A = +25 °C, All Unused Ports Terminated with 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
2nd and 3rd harmonics	2fo, 3fo	P_{OUT} ≤ +21 dBm, 1 Mbps, CCK P_{OUT} ≤ +18 dBm, 802.11g/n, all data rates			–40 –50	dBm/MHz dBm/MHz
Delay and rise/fall time	t_{DR}, t_{DF}	50% of V_{EN} edge and 90/10% of final output power level		0.2	0.4	µs
Input return loss	|S11|		9	10		dB
Stability	STAB	CW, P_{OUT} = +21 dBm, 0.1 to 21 GHz, load VSWR = 6:1	All non-harmonically related outputs <–42 dBm/MHz			–
Ruggedness	Ru	TG = +12 dBm, ANT load varies over 6:1 VSWR	No irreversible damage			–

Note 1: Performance is guaranteed only under the conditions listed in this Table.

Table 8. SKY85803 Electrical Specifications: 2.4 GHz Receive Characteristics (Note 1)
(V_{CC} = 3.3 V, Switch Condition 1, T_A = +25 °C, All Unused Ports Terminated with 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
Frequency range	f		2400		2500	MHz
Small signal gain, LNA enabled	S21	2400 to 2485 MHz	10	14	16	dB
Small signal gain, bypass mode	S21	LNA bypassed, switch condition 3	–12		–10	dB
Small signal gain, high band gain @ 5150 to 5850 MHz	S21			–10		dB
Small signal gain variation	ΔS21	2400 to 2485 MHz, over any 40 MHz band		0.25	0.50	dB
Noise Figure	NF	De-embedded to device		2.5	2.8	dB
Input return loss	|S11|		5	10		dB
1 dB input compression point	IP1dB	LNA enabled LNA bypassed, switch condition 3		–7 +8		dBm dBm
Loopback isolation (ANT to RG pins)	LB	Switch condition 2, P_{OUT} = P_{SAT}	P_{SAT} + 10	40		dB
Enable time	t_{EN}	10% to 90% of receive RF power from time that C0 signal is at 50%			0.2	µs

Table 9. SKY85803 Electrical Specifications: 5.0 GHz Transmit Characteristics (Note 1)
(V_{CC} = ENA = C0 = 3.3 V, ENG = C1 = 0 V, T_A = +25 °C, All Unused Ports Terminated with 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
Frequency range	f		4900		5900	MHz
Output power, 802.11n	$P_{OUT\_802.11N}$	OFDM signal, MCS7, HT40, DEVM = 3%, 802.11n mask compliant, ±11 MHz offset, RBW = 100 kHz, VBW = 30 kHz DEVM = 2%		+16 +15		dBm dBm
Output power, 802.11ac	$P_{OUT\_802.11AC}$	80 MHz, 256 QAM, MCS9, DEVM = 1.8%, input signal EVM < 0.6%, 802.11ac mask compliant DEVM = 1.2%		+13 +12		dBm dBm
1 dB compression point	P1dB		+21.0	+22.5		dBm
Small signal gain	S_{21}	In band @ 1.9 GHz @ 3.9 GHz	+23		+30 –20 +4	dB dB dB
Small signal gain variation over 80 MHz channel	$\Delta\lvert S_{21}\rvert$		–1		+1	dB
Small signal gain variation over sub-bands	$\Delta\lvert S_{21}\rvert$	4.90 to 5.18 GHz, 5.18 to 5.50 GHz, 5.50 to 5.90 GHz		2	3	dB
Isolation	S_{12}	Switch state 5, 4.9 to 5.9 GHz			–45	dB
2nd and 3rd harmonics	2fo, 3fo	@ +16 dBm, 54 Mbps, 802.11a			–50	dBm/MHz
Delay and rise/fall time	t_{DR}, t_{DF}	50% of V_{EN} edge and 90/10% of final output power level		0.2	0.4	µs
Input return loss	$\lvert S_{11}\rvert$			10		dB
Output return loss	$\lvert S_{22}\rvert$			10		dB
Stability	STAB	64 QAM, P_{OUT} = +16 dBm, 0.1 to 21 GHz, load VSWR = 6:1	All non-harmonically related outputs <–42 dBm/MHz			–
Ruggedness	Ru	TA = +12 dBm, ANT load varies over 6:1 VSWR	No irreversible damage			–

Table 10. SKY85803 Electrical Specifications: 5.0 GHz Receive Characteristics (Note 1)
(VCC = 3.3 V, Switch Condition 4, TA = +25 °C, All Unused Ports Terminated with 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
Frequency range	f		4900		5850	MHz
Small signal gain	S21	4900 to 5850 MHz	10	12	14	dB
Small signal gain, bypass mode	S21	LNA bypassed, switch condition 6	–14		–10	dB
Small signal gain, low band gain @ 2400 to 2500 MHz	S21			–10		dB
Small signal gain variation	Δ|S21|	4900 to 5850 MHz, over any 80 MHz band	–0.5		+0.5	dB
Noise Figure	NF	De-embedded to device		2.8	3.0	dB
Input return loss	|S21|		8	10		dB
Output return loss	|S22|		6	10		dB
1 dB input compression point	IP1dB	LNA enabled LNA bypassed, switch condition 6	–6 +6			dBm dBm
Loopback isolation (TA to RA pins)	LB	Switch condition 5, $P_{OUT} = P_{SAT}$		–40		dB
Enable time	t_{EN}	10% to 90% of receive RF power from time that C0 signal is at 50%			0.2	µs

Table 11. SKY85803 Electrical Specifications: 2.0 GHz Power Detector Characteristics (Note 1)
(VCC = 3.3 V, Switch Condition 2, TA = +25 °C, All Unused Ports Terminated with 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
Frequency range	f		2400		2500	MHz
Power detector range, peak power	PDR	Measured at ANT pin	0		+22	dBm
DC output impedance	PDZ_{OUT}			2.3		kΩ
Output voltage @ P_{OUT} = +21 dBm	PDV_{P21}	Measured into 26.5 kΩ		0.80		V
Output voltage @ P_{OUT} = +18 dBm	PDV_{P18}	Measured into 26.5 kΩ		0.60		V
Output voltage, no RF output power	PDV_{PNORF}	Measured into 26.5 kΩ		0.20		V
Power detector low-pass filter –3 dB corner frequency	$LPF\text{-}3_{DB}$	Measured into 26.5 kΩ	70			MHz
Power detector accuracy	$PDET_{ACC}$	Measured into 3:1 load at ANT port	–1.5		+1.5	dB

Table 12. SKY85803 Electrical Specifications: 5.0 GHz Power Detector Characteristics (Note 1)
(V_{CC} = 3.3 V, Switch Condition 5, T_A = +25 °C, All Unused Ports Terminated with 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
Frequency range	f		4900		5900	MHz
Power detector range, peak power	PDR	Measured at ANT pin	0		+21	dBm
DC output impedance	PDZ_{OUT}			26.5		kΩ
Output voltage @ P_{OUT} = +18 dBm	PDV_{P18}	Measured into 26.5 kΩ		0.70		V
Output voltage @ P_{OUT} = +16 dBm	PDV_{P21}	Measured into 26.5 kΩ		0.60		V
Output voltage, no RF output power	PDV_{PNORF}	Measured into 26.5 kΩ		0.20		V
Power detector low-pass filter –3 dB corner frequency	$LPF\text{-}3_{DB}$	Measured into 26.5 kΩ	70			MHz
Power detector accuracy	$PDET_{ACC}$	Measured into 3:1 load at ANT port	–2		+2	dB

Typical Performance Characteristics

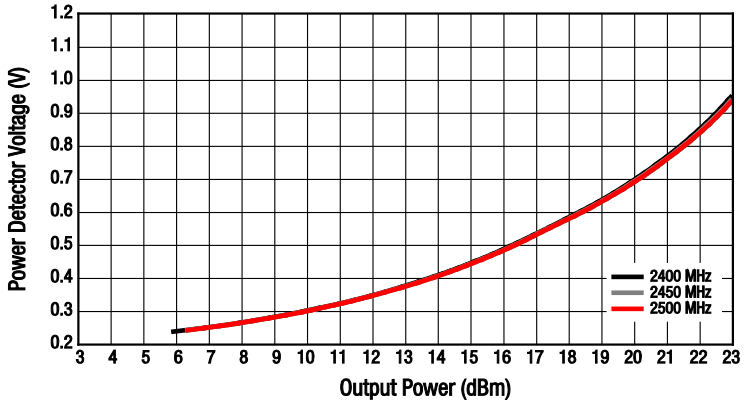


Figure 3. Power Detector vs Output Power Over Frequency @ 2.5 GHz

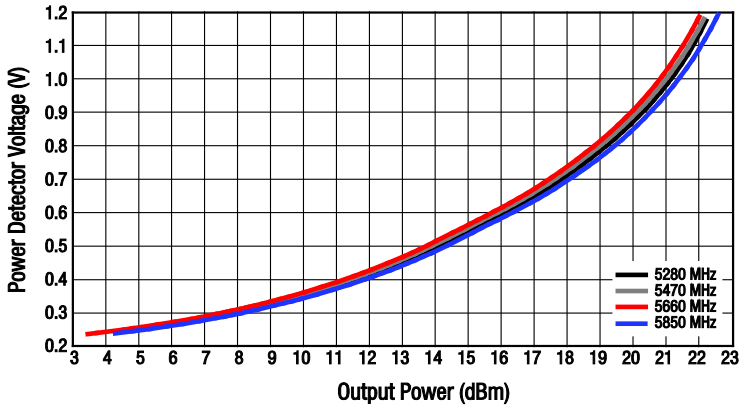


Figure 4. Power Detector vs Output Power Over Frequency @ 5.0 GHz

Evaluation Board Description

The SKY85803 Evaluation Board is used to test the performance of the SKY85803 WLAN FEM. An Evaluation Board schematic diagram is provided in Figure 5. A photograph of the Evaluation Board is shown in Figure 6. Component values for the SKY85803 Evaluation Board are listed in Table 14.

Evaluation Board Setup Procedure

Step 1: Connect system ground to pin 2 of connector J6.

Step 2: Apply 3.3 V to pin 1 of connector J6.

Step 3: Select a path according to the logic shown in Table 13.

Package Dimensions

The PCB layout footprint for the SKY85803 is provided in Figure 7. Typical case markings are shown in Figure 8. Package dimensions for the 24-pin LGA are shown in Figure 9, and tape and reel dimensions are provided in Figure 10.

Package and Handling Information

Since the device package is sensitive to moisture absorption, it is baked and vacuum packed before shipping. Instructions on the shipping container label regarding exposure to moisture after the container seal is broken must be followed. Otherwise, problems related to moisture absorption may occur when the part is subjected to high temperature during solder assembly.

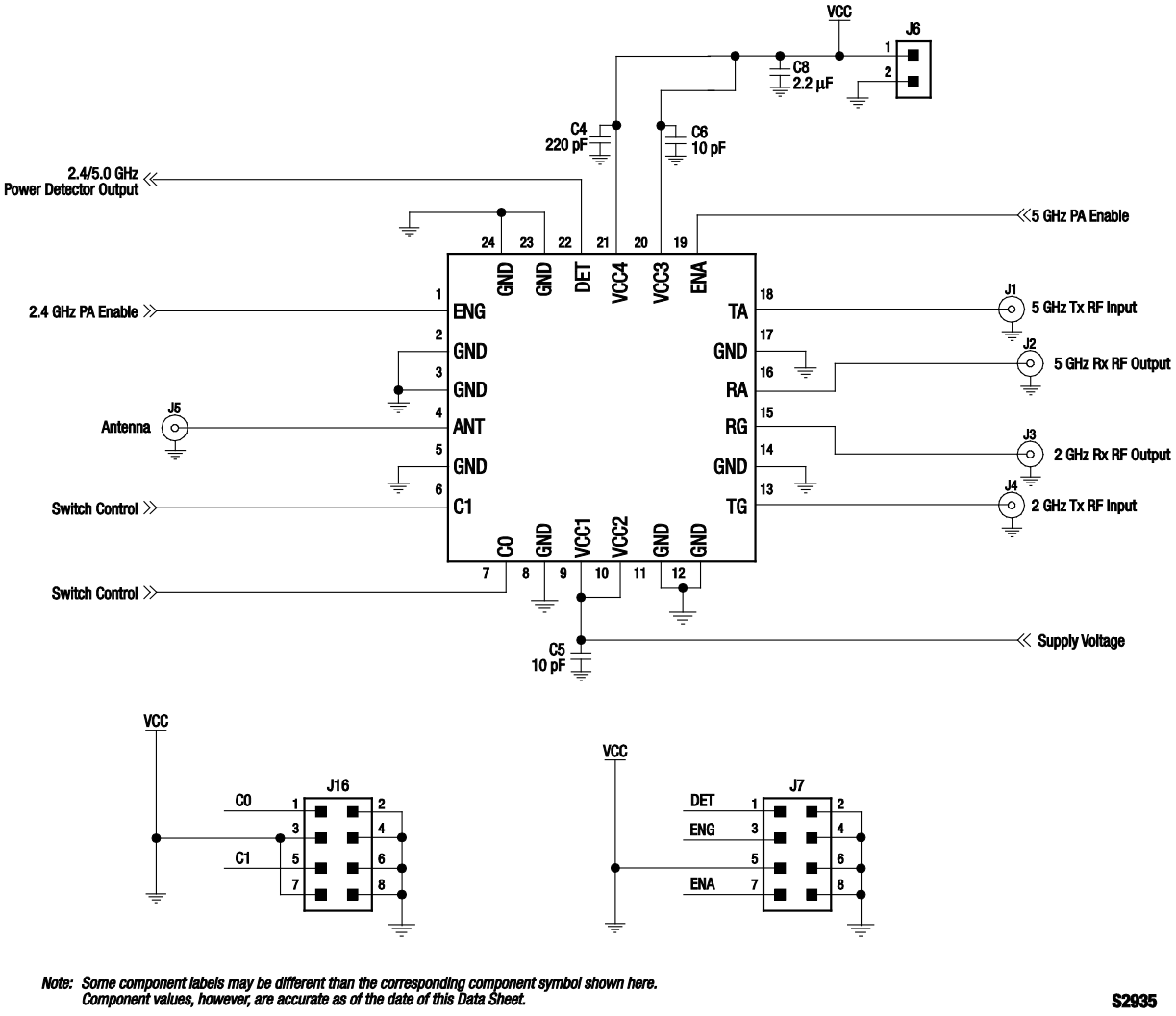
THE SKY85803 is rated to Moisture Sensitivity Level 3 (MSL3) at 250 °C. It can be used for lead or lead-free soldering. For additional information, refer to the Skyworks Application Note, *Solder Reflow Information*, document number 200164.

Care must be taken when attaching this product, whether it is done manually or in a production solder reflow environment. Production quantities of this product are shipped in a standard tape and reel format.

Table 13. SKY85803 Evaluation Board Switch Control Logic

Condition	Logic				State		
	C0 (Pin 1, J16 Header)	C1 (Pin 5, J16 Header)	ENA (Pin 7, J7 Header)	ENG (Pin 3, J7 Header)	SP3T	LNA	Bypass
1	0	1	0	0	RG	RG enable	Open
2	0	0	0	1	TG	RG off	RG bypass
3	0	0	0	0	RG	RG off	RG bypass
4	1	1	0	0	RA	RA enable	Open
5	1	0	1	0	TA	RA off	RA bypass
6	1	0	0	0	RA	RA off	RA bypass

Note: "0" = 0 V. "1" = +3.3 V. Any state other than described in this Table places the switch into an undefined state. An undefined state will not damage the device.



Note: Some component labels may be different than the corresponding component symbol shown here. Component values, however, are accurate as of the date of this Data Sheet.

S2935

Figure 5. SKY85803 Evaluation Board Schematic

Figure 6. SKY85803 Evaluation Board Photo

Table 14. SKY85803 Evaluation Board Bill of Materials

Component	Size	Value	Vendor	Part #	Comments
C4	0402	220 pF	Murata	GRM1555C1H221JA01	Multilayer ceramic
C5, C6	0402	10 pF	Murata	GRM1555C1H100JZ01	Multilayer ceramic
C8	0805	2.2 μF	Murata	GRM21BR71A225KA01L	Ceramic capacitor, 10 V, 10% X7R

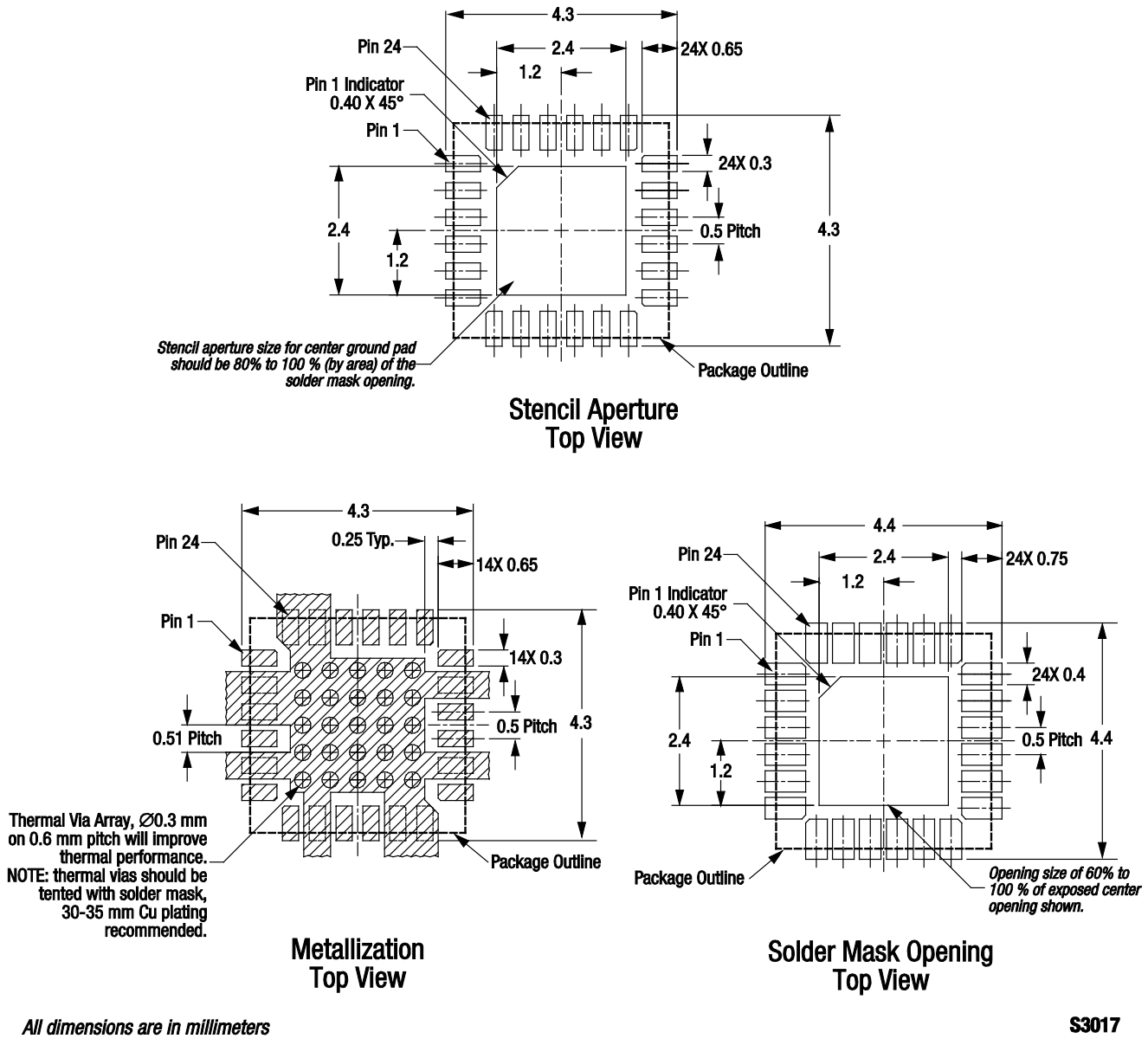
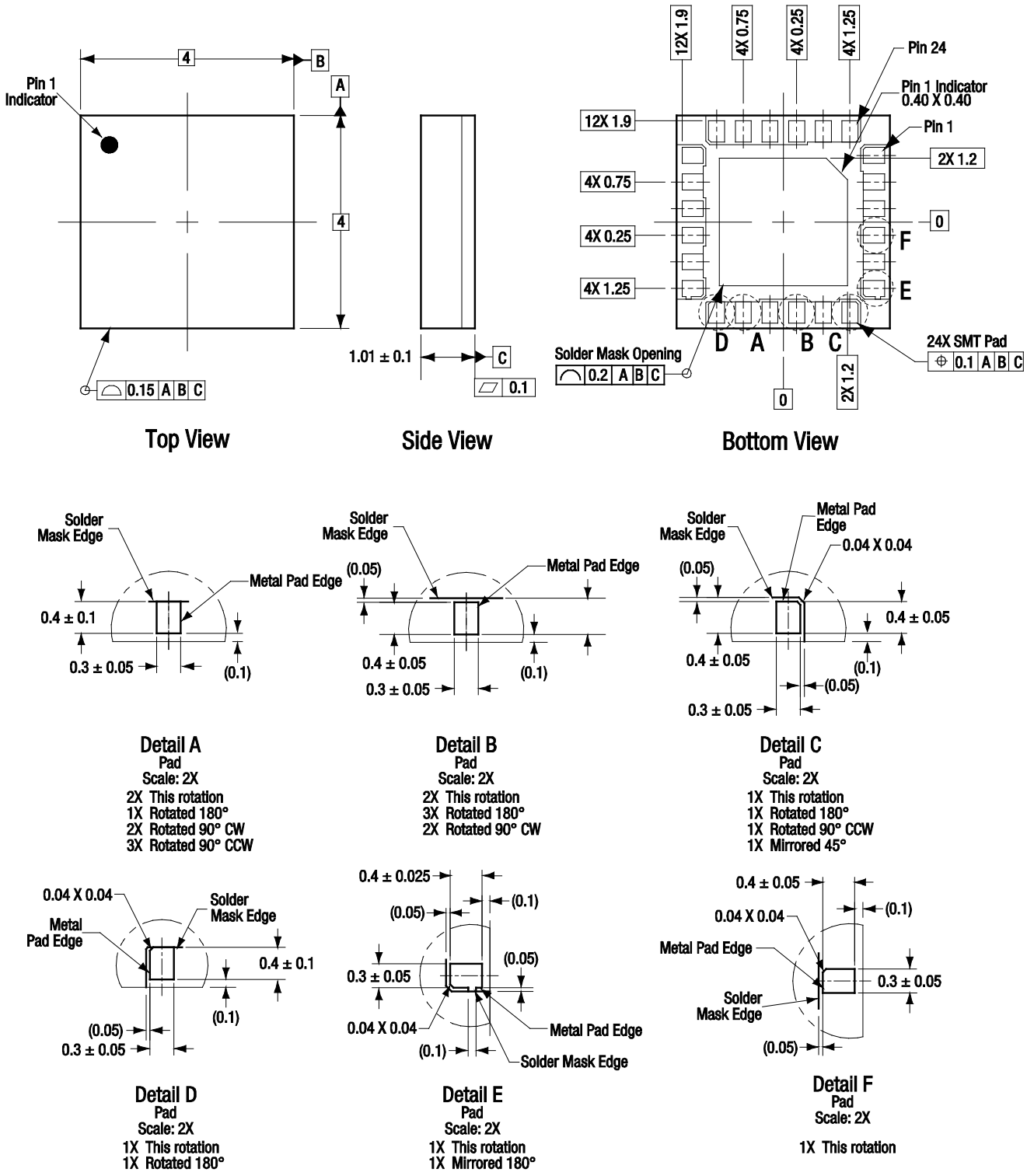


Figure 7. SKY85803 PCB Layout Footprint

*** TBD ***

Figure 8. Typical Case Markings
(Top View)



All measurements are in millimeters

Dimensioning and tolerancing according to ASME Y14.5M-1994

S2933

Figure 9. SKY85803 24-Pin LGA Package Dimensions

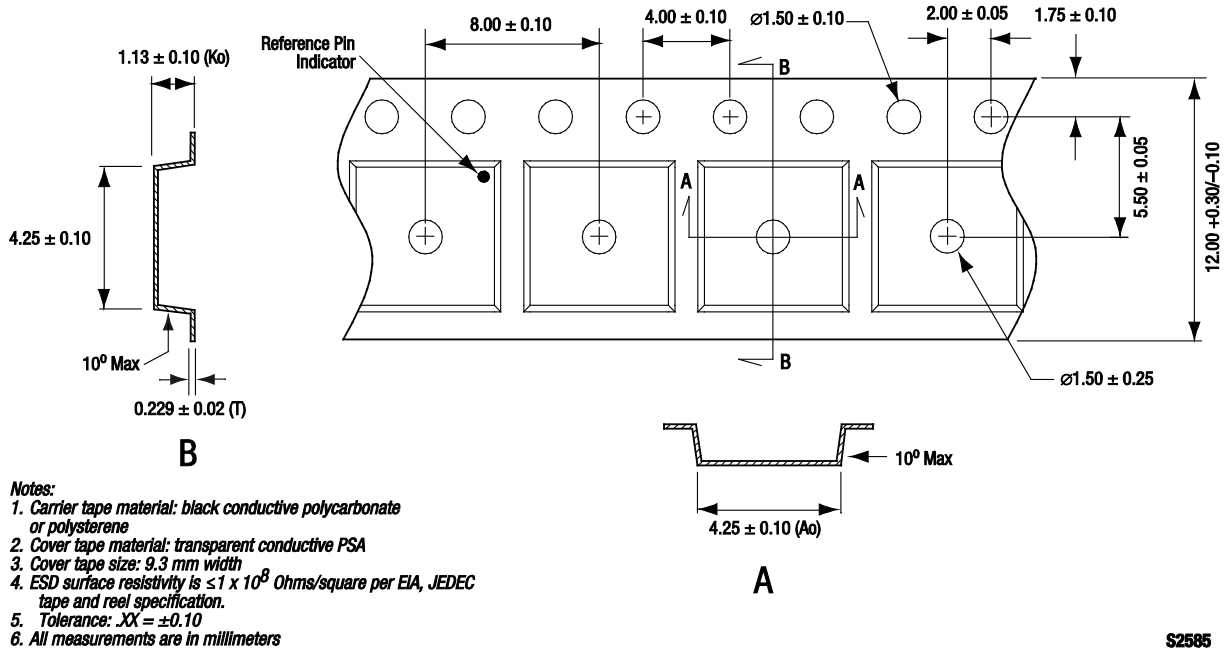


Figure 10. SKY85803 Tape and Reel Dimensions

Ordering Information

Model Name	Manufacturing Part Number	Evaluation Board Part Number
SKY85803 WLAN FEM	SKY85803	SKY85803-EVB

Mouser Electronics

Authorized Distributor

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Skyworks:

SKY85803-11